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ANDERSON ENGINEERING INC SPRINGFIELD MO

NATIONAL DAM SAFETY PROGRAM. E. ANTHONIS LAKE DAM (MO J1135), M--ETC(U)

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**AD A105346**

**E. ANTHONIS LAKE**

**FRANKLIN COUNTY, MISSOURI**

**MO 31135**

**PHASE 1 INSPECTION REPORT  
NATIONAL DAM SAFETY INSPECTION**



**United States Army  
Corps of Engineers  
District**

**St. Louis District**

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		



DEPARTMENT OF THE ARMY  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS  
210 NORTH 12TH STREET  
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: E. Anthonis Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the E. Anthonis Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure
- 3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY:

Chief, Engineering Division

24 AUG 1979

Date

APPROVED BY:

Colonel, CE, District Engineer

24 AUG 1979

Date

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E. ANTHONIS DAM  
FRANKLIN COUNTY, MISSOURI  
MISSOURI INVENTORY NO. 31135

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Prepared By  
Anderson Engineering, Inc., Springfield, Missouri  
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of  
St. Louis District, Corps of Engineers

For  
Governor of Missouri

July 1979

PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	E. Anthonis Dam
State Located:	Missouri
County Located:	Franklin
Stream:	Tributary of Tavern Creek
Date of Inspection:	May 7, 1979

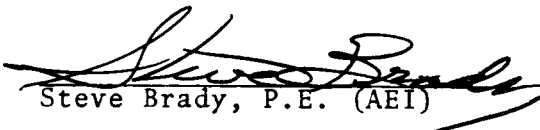
E. Anthonis Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam has been classified by the St. Louis District Corps of Engineers as a small size dam with a high downstream hazard potential. The estimated damage zone extends approximately 1.5 miles downstream of the dam. Several dwellings, buildings, a highway, and a 3 acre lake are located within this zone.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 44 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the small size of the dam and the low storage impoundment capacity of the reservoir, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The 100-year frequency flood will not overtop the dam. The 100-year flood is one that has a 1 percent chance of being exceeded in any given year.


Deficiencies visually observed by the inspection team were: (1) heavy brush and tree growth on embankment surface; (2) erosion at the south abutment - dam contact and on the downstream face; (3) small animal burrows in the embankment; (4) weed and cattail growth in the spillway approach channel; (5) wet areas at and beyond downstream toe of embankment; (6) lack of wave protection for upstream face of embankment; and (7) lack of a non-erodible control section for the spillway. Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action in the near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

  
Steve Brady, P.E. (AEI)

  
Gene Wertepny, P.E. (HEI)

  
Dave Daniels, P.E. (HEI)

  
Tom Beckley, P.E. (AEI)

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
E. ANTHONIS DAM - ID No. 31135

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description of the Project	1
1.3	Pertinent Data	2
	SECTION 2 - ENGINEERING DATA	
2.1	Design	6
2.2	Construction	7
2.3	Operation and Maintenance	7
2.4	Evaluation	8
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	9
3.2	Evaluation	10
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	11
4.2	Maintenance of Dam	11
4.3	Maintenance of Operating Facilities	11
4.4	Description of Any Warning System in Effect	11
4.5	Evaluation	11
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	12
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	14
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	15
7.2	Remedial Measures	16



## APPENDICES

	<u>Sheet</u>
APPENDIX A	
Location Map	1
Vicinity Map	2
Plan, Profile and Section of Dam	3
Plan Sketch of Dam	4
APPENDIX B	
Geologic Regions of Missouri	1
Thickness of Loessial Deposits	2
APPENDIX C	
Overtopping Analysis - PMF	1-7
APPENDIX D	
Photographs of Dam and Lake	1-4

## SECTION 1 - PROJECT INFORMATION

### 1.1 GENERAL:

#### A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of E. Anthonis Dam in Franklin County, Missouri.

#### B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

#### C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

### 1.2 DESCRIPTION OF PROJECT:

#### A. Description of Dam and Appurtenances:

E. Anthonis Dam is an earth fill structure approximately 39 ft high and 420 ft long at the crest. The only spillway associated with the dam is an unlined earth swale (uncontrolled crest) around the north abutment. Sheet 3 of Appendix A shows a plan profile and typical section of the embankment.

#### B. Location:

The dam is located in the northeastern part of Franklin County, Missouri on a tributary of Tavern Creek. The dam and lake are within the Eureka, Missouri 7 1/2 minute quadrangle sheet (Section 13, T44N, R02E - latitude 38° 33.3'; longitude 90° 44.91'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 39 ft and a maximum storage capacity of approximately 43 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately 1.5 miles downstream of the dam. Several dwellings, buildings, a highway, and a 3 acre lake are located within this zone.

E. Ownership:

The dam is owned by Mr. Edward Anthonis. The owner's address is 10449 St. Charles Road, St. Ann, Missouri 63074.

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes, although some flood protection is also provided.

G. Design and Construction History:

No design information is available. The dam was built in the mid 1960's with material removed from the lake area. Mr. Anthonis indicated that a key trench was utilized, although its depth and width are unknown. Plans for construction are not available. No problems concerning seepage through or stability of the embankment are reported to have occurred since the dam was built. To our knowledge, no modifications have been made since the original construction.

H. Normal Operating Procedures:

All flows will be passed by an uncontrolled earth swale spillway at the north end of the dam (Sheet 3, Appendix A). The owner indicates that the dam has never been overtopped.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 51 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 96.8): 261 cfs
- (3) Estimated Capacity of Primary Spillway: 261 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: 200 cfs (Elev. 96.4)
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed elevation of 100.00 for the corner of the rock outcrop at Station 0-18, 18 ft right of centerline (see Sheet 3, Appendix A).

- (1) Top of Dam: 96.8 (Low Point); 98.7 (High Point)
- (2) Spillway Crest: 94.3
- (3) Principal Outlet Pipe Invert: Not Applicable
- (4) Streambed at Centerline of Dam: 59.7
- (5) Pool on Date of Inspection: 94.4
- (6) Apparent High Water Mark: 96.4
- (7) Maximum Tailwater: Unknown

(8) Upstream Portal Invert Diversion Tunnel: Not Applicable

(9) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Principal Spillway Crest: 600 ft

(2) At Top of Dam: 625 ft

E. Storage Capacities:

(1) At Principal Spillway Crest: 35 acre-ft

(2) At Top of Dam: 43 acre-ft

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 3 acres

(2) At Top of Dam: 4 acres

G. Dam:

(1) Type: Earth

(2) Length at Crest: 420 ft

(3) Height: 39 ft (Maximum)

(4) Top Width: about 10 ft

(5) Side Slopes: Upstream Irregular; Downstream 2.4H to 1.0V (See Sheet 3, Appendix A)

(6) Zoning: Unknown

(7) Impervious Core: Unknown

(8) Cutoff: Shallow core trench (Depth and width unknown)

(9) Grout Curtain: Unknown

H. Diversion and Regulating Tunnel:

- (1) Type: Not Applicable
- (2) Length: Not Applicable
- (3) Closure: Not Applicable
- (4) Access: Not Applicable
- (5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

- (1) Location: North abutment
- (2) Type: Uncontrolled earth swale

I.2 Emergency Spillway:

- (1) Location: Not Applicable
- (2) Type: Not Applicable

J. Regulating Outlets:

There are no regulating or dewatering facilities associated with this dam.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN:

No design computations or reports for E. Anthonis Dam are available. No documentations of construction inspection records have been obtained. The owner indicated that personnel from the Missouri Conservation Commission visited the site periodically during construction to offer their assistance. To our knowledge, there are no documented maintenance data.

#### A. Surveys:

No information regarding pre-construction surveys could be obtained. Sheet 3 of Appendix A presents a plan, profile and cross section of the dam from survey data obtained during the site inspection. The corner of the rock outcrop at station 0-18, 18 ft right of centerline, was used as a site datum of assumed elevation 100.00 (see Sheet 3, Appendix A).

#### B. Geology and Subsurface Materials:

The site is located near the northeastern limit of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus and deep valleys. The most common bedrock types are dolomite, sandstone and chert.

Information supplied by the Missouri Geological Survey indicates that the bedrock in the valley consists of the Plattin and Decorah formations of the Champlainian Series in the Ordovician System. The Plattin formation is composed of evenly bedded, dark gray, finely crystalline to sublithographic limestone. The Plattin formation has fracture permeability and is pinnacled. The overlying Decorah formation consists of green or brown shales and has numerous, thin, interbedded limestone layers in its lower part that grade upward into a medium to thinly bedded, fossiliferous limestone which contains thin, fossiliferous shale partings. The Decorah formation, some 12 to 15 ft thick, makes a good foundation bedrock for small dams.

The valley slopes are a permeable limestone, the Kimmswick formation. The publication "Caves of Missouri" indicates that while numerous caves are known to exist in Franklin County, they are densely clustered in the south-central part of the county, at least 25 miles from the site.

The rock units at the site weather to a thin stoney loam to stoney clay soil. These soils are generally of low permeability and medium to high plasticity. The upland soils, belonging to the Menfro-Winfield-Weldon Soil Association, consist of silty loessial soils no more than 10 to 20 ft thick.

C. Foundation and Embankment Design:

No foundation and embankment design information was available. Seepage and stability analyses apparently were not performed as required in the guidelines. Information from the owner indicates that a core trench was constructed at the base of the dam. The depth, width, extent, and location of the core trench are unknown. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design computations for the E. Anthonis Dam were available. Based on a field check of spillway dimensions and embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 to 7. It was concluded that the structure will pass 44 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

There are no appurtenant structures associated with this dam.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION AND MAINTENANCE:

Normal flows are passed by an uncontrolled earth swale spillway located at the north end of the dam. There are no regulating facilities associated with this dam, and therefore, no operating records are known to exist. Although the owner indicated that the dam was periodically maintained, there is considerable brush and tree growth over the entire surface of the embankment.



## 2.4 EVALUATION:

### A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

### B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

### C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS:

#### A. General:

The field inspection was made on May 7, 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)  
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)  
Gene Wertepny - Hanson Engineers, Inc. (Hydraulics Engineer)  
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)

#### B. Dam:

The dam appears to be generally in good condition. No sloughing or obvious seepage through the embankment was noted, although the abundance of tree and brush growth made it very difficult to thoroughly inspect the downstream face of the dam. The horizontal alignment of the embankment appears to be concave toward downstream, and the crest is variable in height with a swale at each end of the embankment (See Sheet 3, Appendix A). However, no surface cracking or unusual movement was obvious, indicating that the dam was probably constructed in this unusual configuration. Shallow auger probes into the embankment indicated the dam to consist of a reddish brown silty clay with limestone fragments. Information from the owner indicated that borrow material for construction of the embankment was obtained from the lake area.

The embankment surface is covered by thick brush and tree growth, which made it difficult to conduct a thorough investigation of the downstream face. Erosion channels are present at the south abutment-dam contact and in some area of the downstream face. Small animal burrows were observed on the downstream face. Some wet areas were observed at and beyond the embankment toe. However, these wet areas appeared to be the result of poor drainage, and not seepage through or under the embankment. No wave protection is provided for the upstream face of the dam. No instrumentation (monuments, piezometers, etc.) was observed.

### C. Appurtenant Structures:

#### C.1 Primary Spillway:

The approach channel to the spillway is covered with weeds and cattails. No non-erodible control section is provided for the spillway. One small plunge pool has eroded in the spillway about halfway between the spillway crest and the valley floor. Bedrock is exposed in this plunge pool.

#### C.2 Emergency Spillway:

There is no emergency spillway associated with E. Anthonis Dam.

#### D. Reservoir:

The watershed is generally wooded, with no agricultural activity. The slopes adjacent to the lake are moderate, and no sloughing or serious erosion was noted.

#### E. Downstream Channel:

The spillway outlet channel is overgrown with trees and brush. Bedrock is exposed in a small plunge pool which has been eroded by spillway flows. Downstream, the channel has been cut into the north abutment by erosion.

### 3.2 EVALUATION:

Trees and brush on the dam should be cleared on an annual basis. Vegetation in the approach to the spillway should be removed. The erosional areas and animal holes on the embankment should be corrected and maintained. The upstream face of the dam should be protected to resist erosion. A non-erodible control section should be provided for the spillway so that progressive erosion does not lower the elevation of the spillway, and thus lower the normal pool elevation of the reservoir. Positive drainage for the wet areas beyond the toe of the dam should be provided.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES:

There are no controlled outlet works for this dam. The spillway is uncontrolled, so that the pool is normally controlled by rainfall, runoff and evaporation.

### 4.2 MAINTENANCE OF DAM:

Abundant brush and tree growth indicates that the dam has not been maintained in recent years.

### 4.3 MAINTENANCE OF OPERATING FACILITIES:

There are no operating facilities for this dam.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

### 4.5 EVALUATION:

The unprotected, unlined spillway is a serious deficiency which should be rectified. If the existing spillway is used, then considerable erosion could occur at the north abutment and abutment-dam contact so that the stability of the embankment is endangered. Any tree and brush growth should be removed from the dam and outlet channel on a yearly basis. Removal of large trees should be performed under the guidance of an engineer experienced in the design and construction of earth dams. Erosional areas as previously discussed should be repaired. Erosion control measures should be used to prevent future erosion on the upstream face of the dam. Animal burrows should be repaired and maintained.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES:

#### A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field survey of spillway dimensions and embankment elevations, and (2) an estimate of the pool and drainage areas from the U.S.G.S. quad sheet. Mr. Anthonis indicated that the dam had never been overtopped. A recent, apparent high water mark was visible at elevation 96.4 (2.0 ft above normal pool). Our hydrologic and hydraulic analyses using U.S. Army Corps of Engineers guidelines appear in Appendix C.

#### C. Visual Observations:

The approach to the spillway should be cleared of vegetation. A non-erodible control section should be provided so that the crest elevation of the spillway does not erode, thus lowering the normal pool of the lake. Trees and brush should be removed from the outlet channel. The condition of the spillway should be monitored periodically to insure that flows over the unlined and unprotected spillway have not endangered the integrity of the dam.

#### D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 44 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the small size of the dam and the low storage capacity of the reservoir, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The structure will pass a 100-year frequency flood without overtopping.

The routing of 50 percent of the PMF through the spillway and dam indicates that the dam will be overtopped by 0.14 ft at elevation 96.94. The duration of the overtopping will be 0.08 hours, and the maximum outflow will be 590 cfs. The maximum discharge capacity of the spillway is 261 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY:

#### A. Visual Observations:

Visual observations which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

#### B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

#### C. Operating Records:

No operating records have been obtained.

#### D. Post-Construction Changes:

The owner reported that there had been no post-construction changes to the dam.

#### E. Seismic Stability:

The structure is located in seismic zone 2, immediately adjacent to zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

#### A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) heavy brush and tree growth on the dam; (2) erosion at the south abutment-dam contact and on the downstream face of the dam; (3) animal burrows in the embankment; (4) lack of wave protection for the upstream face of the dam; (5) vegetation in the spillway approach channel; (6) lack of a non-erodible control section for the spillway; (7) wet areas at and beyond the toe of the embankment; and (8) lack of seepage and stability analyses comparable to the requirements of the recommended guidelines.

The dam will be overtopped by flows in excess of 44 percent of the Probable Maximum Flood. Calculations indicate that 50 percent of the PMF will overtop the dam by 0.14 ft for a duration of 0.08 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

#### B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by the owner, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

#### C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if



good maintenance is not provided, the embankment condition will deteriorate and possibly could become serious in the future. Priority should be given to removing the brush and tree growth and providing a non-erodible control section for the spillway.

D. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 2, immediately adjacent to zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

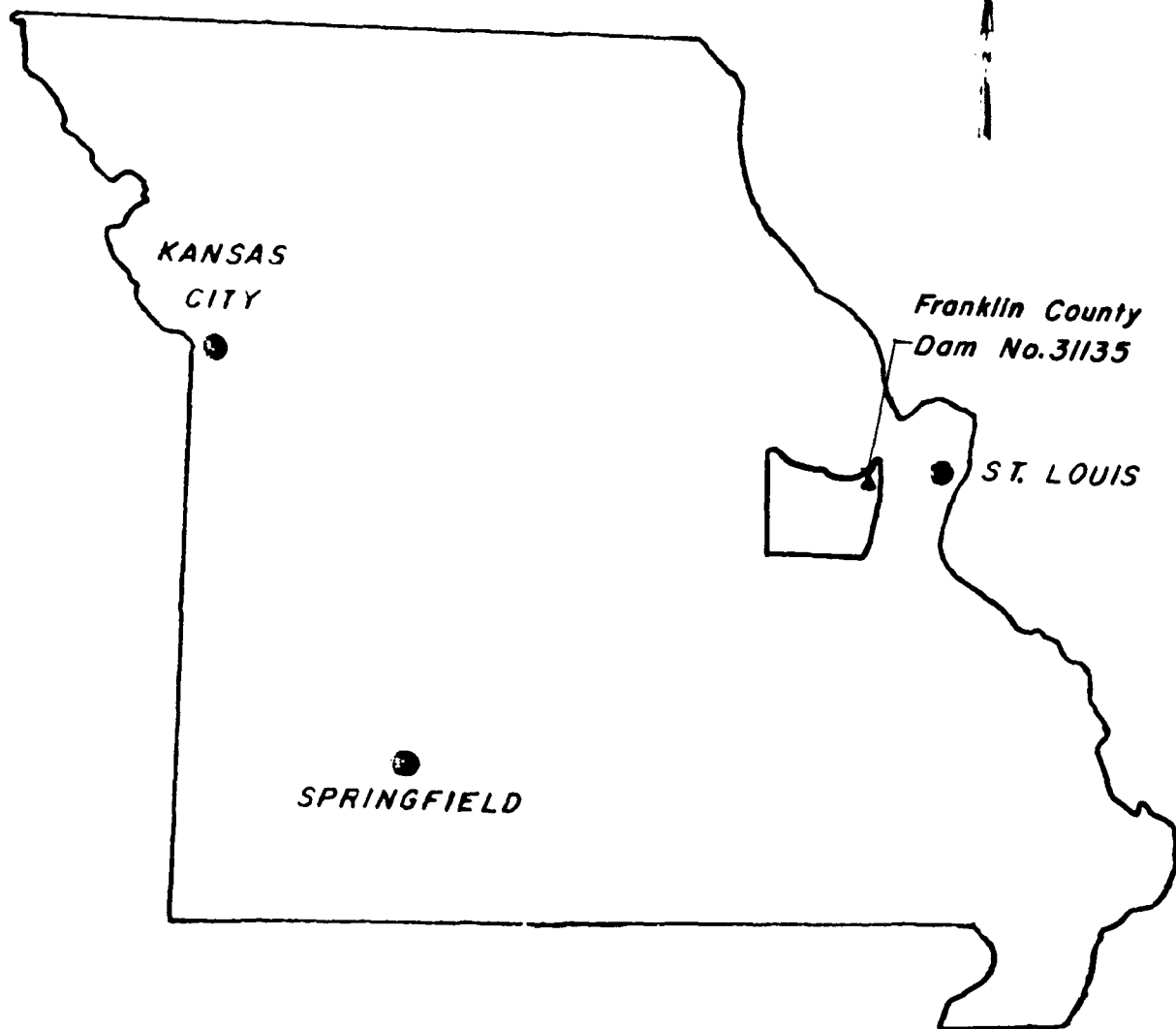
7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

- (1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.
- (2) A non-erodible spillway control section should be provided so that progressive erosion of the spillway will not lower the normal pool of the reservoir.
- (3) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.
- (4) Brush and tree growth should be removed from the dam and from the approach to the spillway. This should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam. Brush and tree growth should then be removed from the dam on an annual basis.
- (5) Erosional areas as previously discussed should be repaired and maintained.

- (6) Animal burrows in the embankment should be repaired.
- (7) Positive drainage should be provided for the wet areas at or beyond the toe of the dam. These areas should periodically be monitored to detect possible seepage problems.
- (8) Wave protection should be provided for the upstream face of the embankment.
- (9) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

*APPENDIX A*

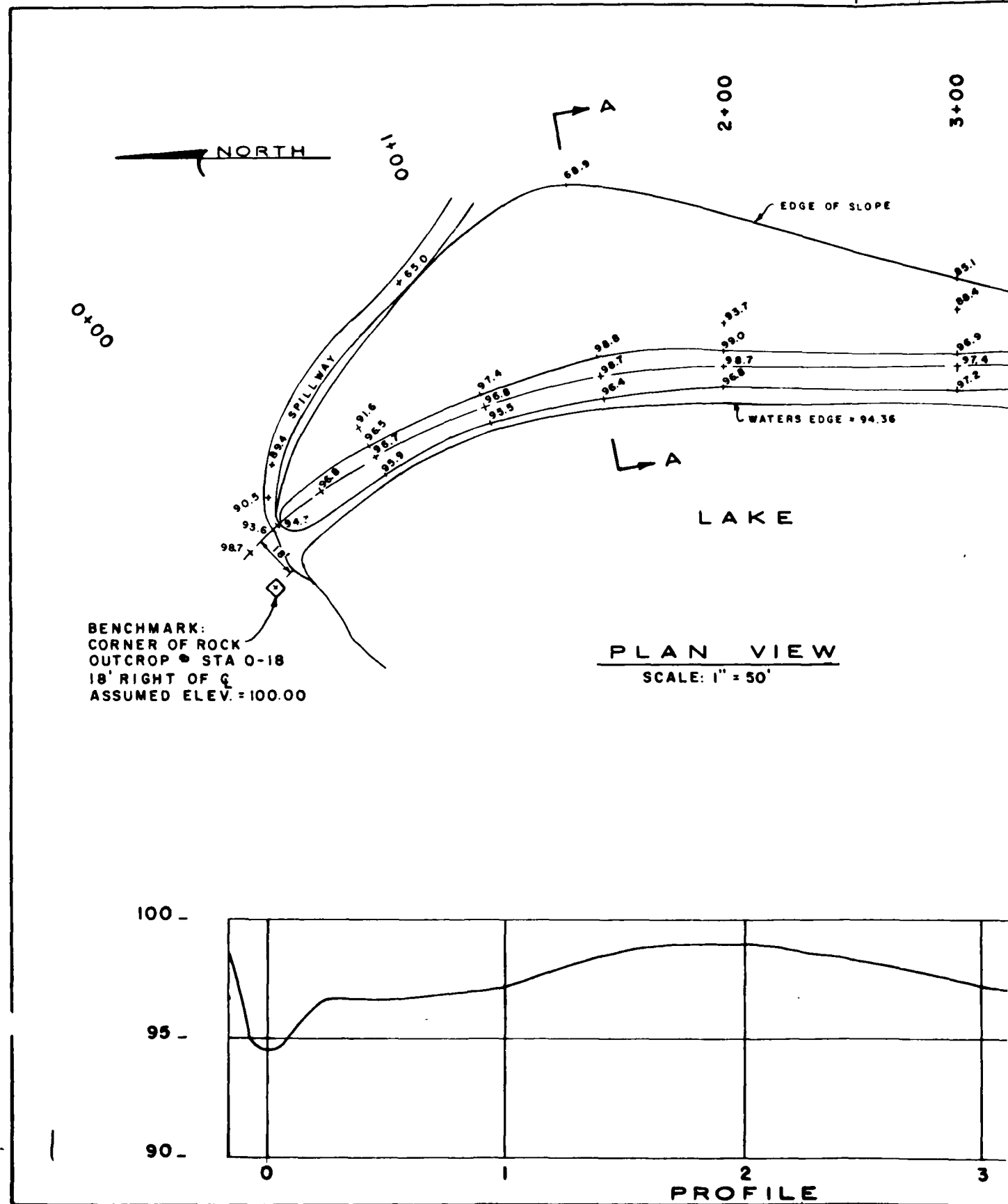


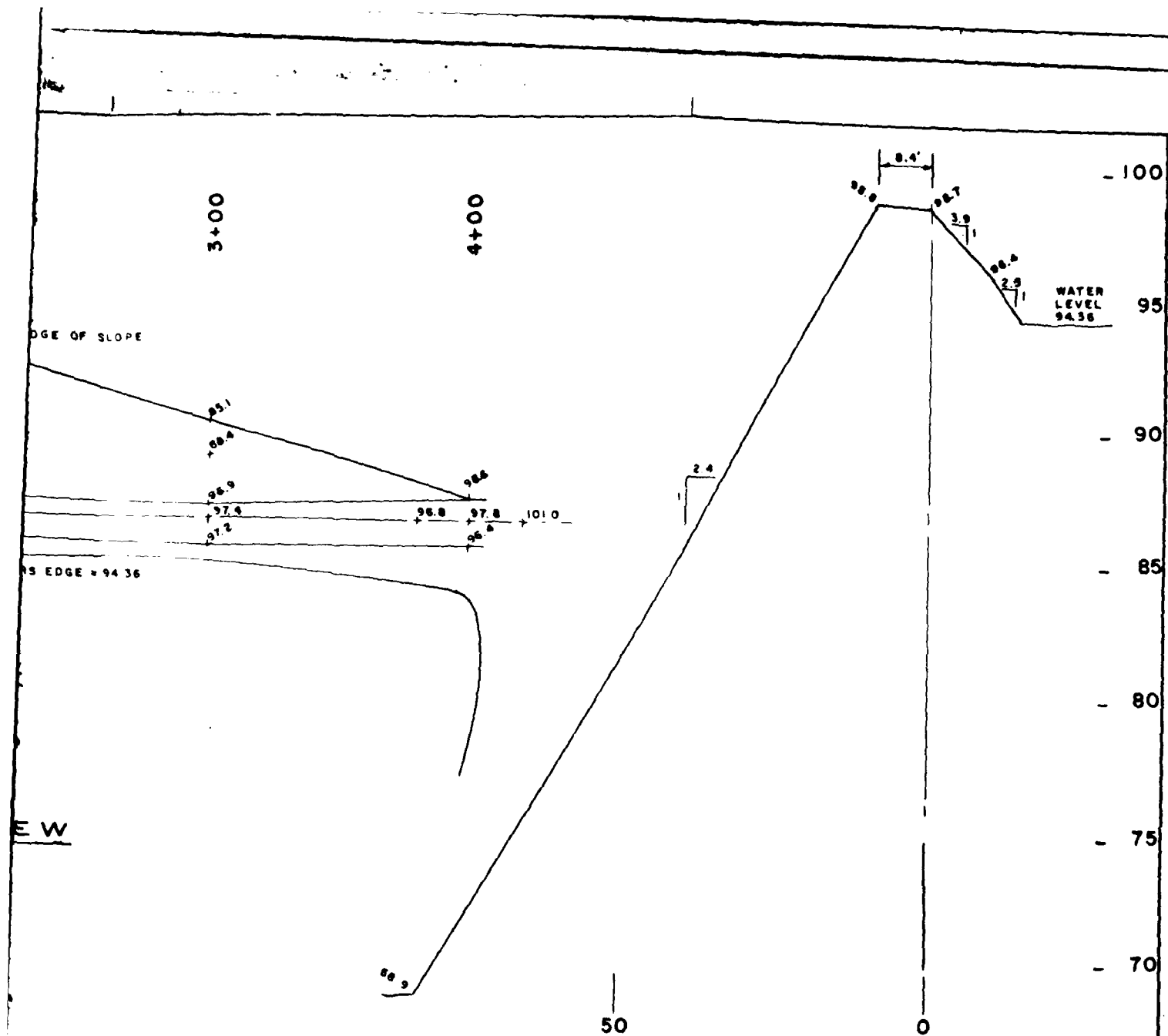
LOCATION MAP



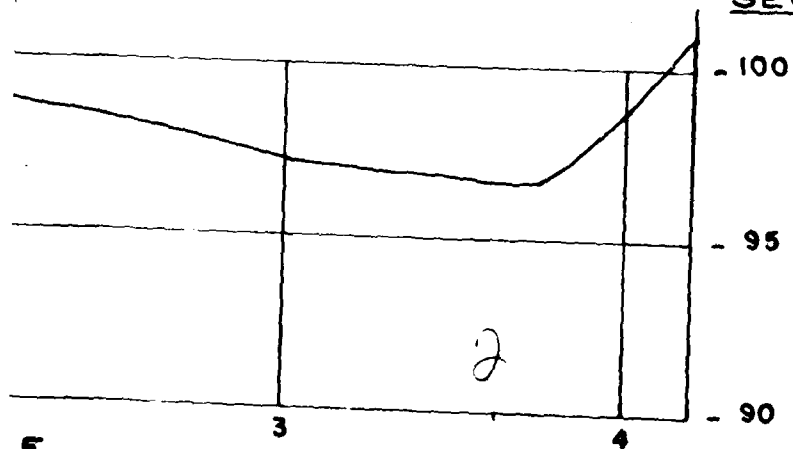
**SITE VICINITY MAP**

**Sheet 2 Appendix A**





SECTION A-A STA 1+50



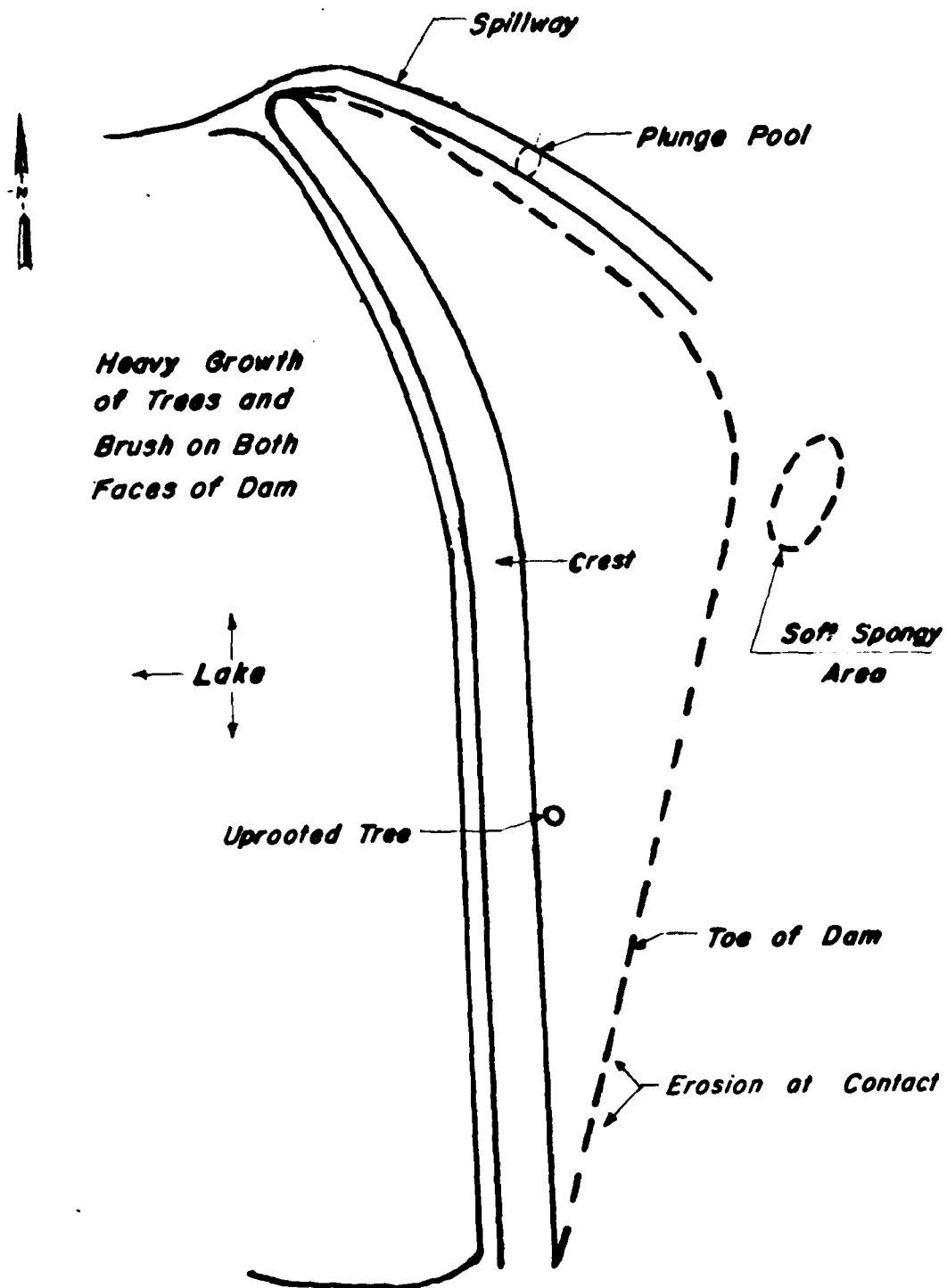
ANDERSON ENGINEERING, INC.  
730 NORTH BENTON AVENUE  
SPRINGFIELD, MISSOURI 65802

MO. No 31135

PLAN & PROFILE

Sheet 3 Appendix A

FRANKLIN COUNTY, MO.



DRAWN DER  
 CHECKED DED  
 DATE 6-14-79  
 JOB NO. 79511



HANSON  
ENGINEERS

SPRINGFIELD ILL.

PEORIA ILL.

*Plan Sketch*

*Inspection Observations*

*Sheet 4 Appendix A*



*APPENDIX B*

This geological map of Missouri illustrates the state's major geological features. The map is bounded by a thick black line representing the state's outline. Key features include:
 

- Plains:** A large area in the western half of the state is filled with a cross-hatch pattern, representing the Plains.
- NTS (Not To Scale):** A label 'NTS.' is located in the central part of the state.
- Rocky Mountain Front:** A label 'Rocky Mountain Front' is located in the northern part of the state.
- Dam No. 31135:** A small black dot in the northwestern corner of the state is labeled 'Dam No. 31135'.
- Other Features:** A large oval-shaped area in the northeast is filled with a diagonal line pattern. A smaller, irregularly shaped area in the south is filled with a stippled pattern.

**\*\* From "Geologic History of Missouri" by Beveridge**

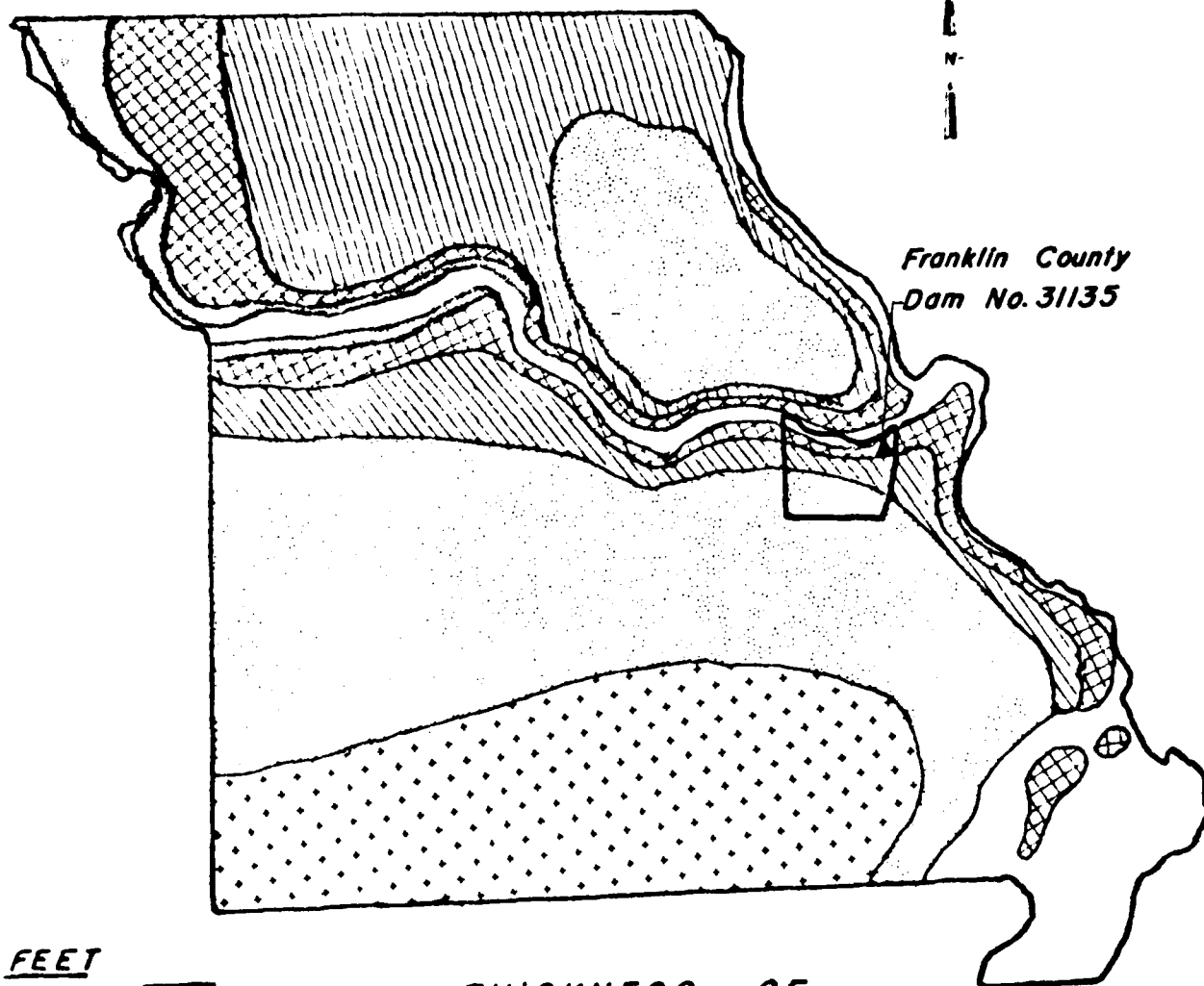
**-Dom No 31135**

2



1111

\* From "Soils of Missouri"



FEET

20+



10-20



( 5-10



2.5-5



2.5-



THICKNESS OF  
LOESSIAL DEPOSITS

SHEET 2 OF APPENDIX B

*APPENDIX C*

From Eureka 8 Lobdell 7.5 Quad

Scale 1: 24,000

St. Albans

Creek

Road

Graves

Lake

Quarry

Watershed

**Sheet 1 Appendix C**

## HYDRAULIC AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available.

Visual Inspection: At the time of the inspection, the pool level was approximately 0.06 ft above normal pool.

Overtopping Potential: Flood routings were performed to determine the overtopping potential. The watershed and the reservoir surface areas were obtained by planimeter from the U.S.G.S. Eureka and Labadie, Missouri 7.5 minute quadrangle maps. The storage volume was developed from these data. A 5 minute interval unit graph was developed for this watershed, which resulted in a peak inflow of 460 c.f.s. and a time to peak of 5 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 1459 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Based on our analyses, the spillway will pass 44 percent of the Probable Maximum Flood (PMF). The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (small size with high downstream hazard potential) pass 50 to 100 percent of the PMF, without overtopping. Considering the small size of the dam and the low storage impoundment capacity of the reservoir, 50 percent of the PMF has been determined to be the appropriate spillway design flood.

The routing of 50 percent of the PMF through the spillway and dam indicates that the dam will be overtopped by 0.14 ft at elevation 96.94. The duration of the overtopping will be 0.08 hours, and the maximum outflow will be 590 c.f.s. The maximum discharge capacity of the spillway at top of dam is 261 c.f.s. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam.

# OVERTOPPING ANALYSIS FOR DAM No. 31135

## INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.  
Hydraulic Inputs Are As Follows:
  - a. Twenty-four Hour Rainfall of 25.2 Inches For 200 Square Miles - All Season Envelope
  - b. Drainage Area = 51 Acres; = 0.08 Sq. Miles
  - c. Travel Time of Runoff 0.07 Hrs.; Lag Time 0.04 Hrs.
  - d. Soil Conservation Service Soil Group B
  - e. Soil Conservation Service Runoff Curve No. 74 (AMC III)
  - f. Proportion of Drainage Basin Impervious 6%
2. Spillways
  - a. Primary Spillway: Low Section Along North Abutment;  
Length 14 ft; Side Slope 4:1; C = 3.0 Q = CLH 3/2
  - b. Emergency Spillway  
Length - Ft.; Side Slopes -; C = -
  - c. Dam Overflow  
Length 420 Ft.; Crest El. 96.8; C = 3.0
3. Spillway and Dam Rating:

Curve Prepared by Hanson Engineers. Data Provided To Computer on Y4 and Y5 Cards.

Note: Time of Concentration From Equation  $T_c = \frac{(11.9 L^3)^{.385}}{H}$   
California Culvert Practice, California Highways and Public Works, Sept. 1942.

### SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
  - a. Peak - 460 c.f.s.
  - b. Time to Peak 5 Min.
2. Flood Routings Were Computed by the Modified Puls Method
  - a. Peak Inflow  
50% PMF 693 c.f.s.; 100% PMF 1459 c.f.s.
  - b. Peak Elevation  
50% PMF 96.94 100% PMF 97.25
  - c. Portion of PMF That Will Reach Top of Dam  
44 %; Top of Dam Elev. 96.8 Ft.
3. Computer Input and Output Data are shown on Sheets 5 and 6 of this Appendix.





\*\*\*\*\*

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION					
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
HYDROGRAPH AT	1	0.08	1	0.20	0.30	0.40	0.50	0.60	1.00
	( 0.21)	( 6.33)	( 10.77)	( 223.	( 380.	( 537.	( 693.	( 848.	( 1459.
ROUTED TO	2	0.08	1	99.	176.	248.	590.	754.	1343.
	( 0.21)	( 2.80)	( 4.99)	( 2.80)	( 4.99)	( 7.02)	( 16.70)	( 21.34)	( 38.03)

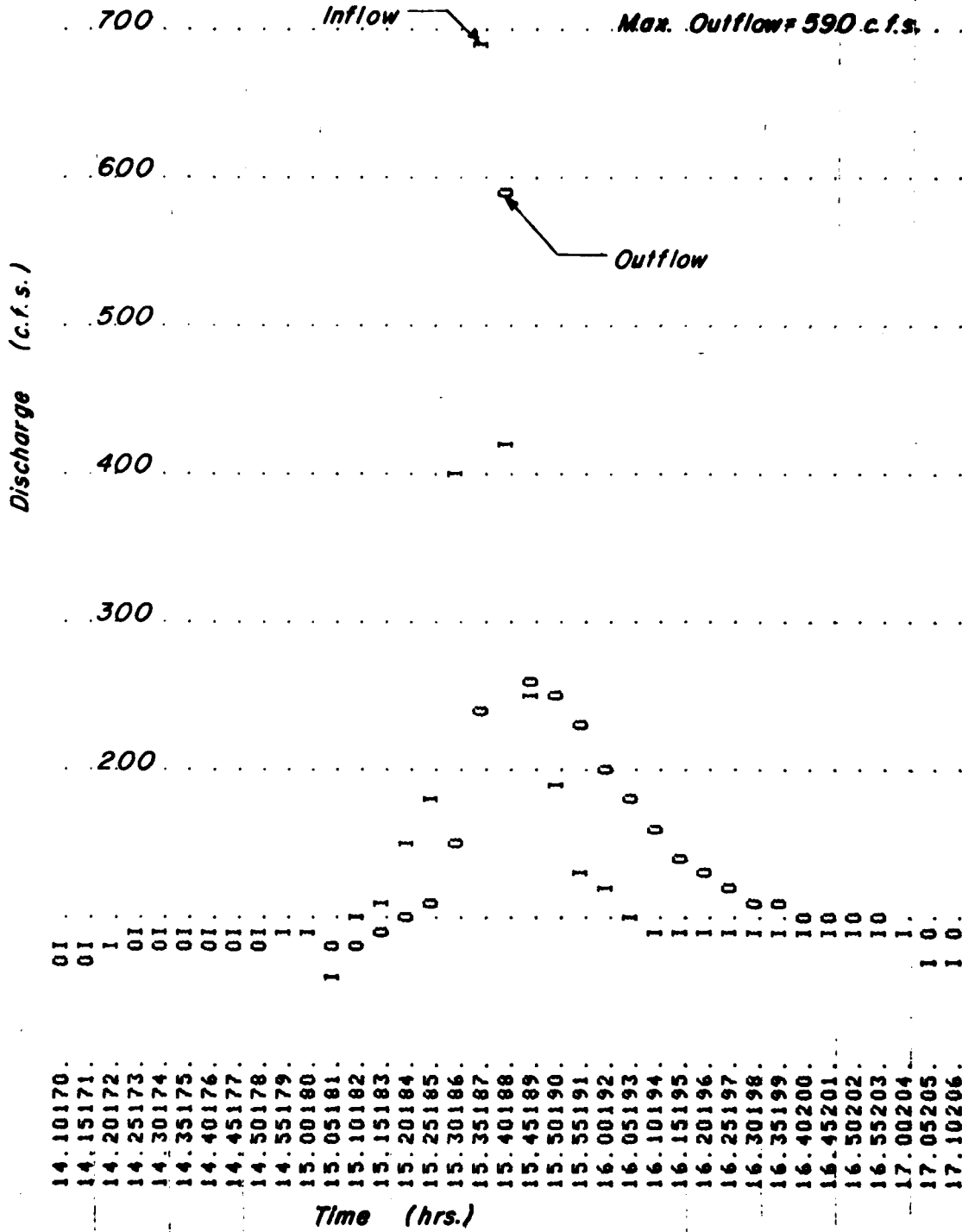
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....			INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
ELEVATION			94.41		94.30		96.80	
STORAGE			35.		35.		43.	
OUTFLOW			5.		0.		261.	
RATIO OF PHF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW		TIME OF FAILURE HOURS
						HOURS		
0.20	95.54	0.00	38.	99.	0.00	15.75	0.00	0.00
0.30	96.14	0.00	40.	176.	0.00	15.75	0.00	0.00
0.40	96.70	0.00	42.	248.	0.00	15.75	0.00	0.00
0.50	96.94	0.14	43.	590.	0.08	15.67	0.00	0.00
0.60	97.00	0.20	44.	754.	0.33	15.67	0.00	0.00
1.00	97.25	0.45	44.	1343.	0.50	15.58	0.00	0.00

# 50% PMF HYDROGRAPHS

Max. Inflow = 693 c.f.s.

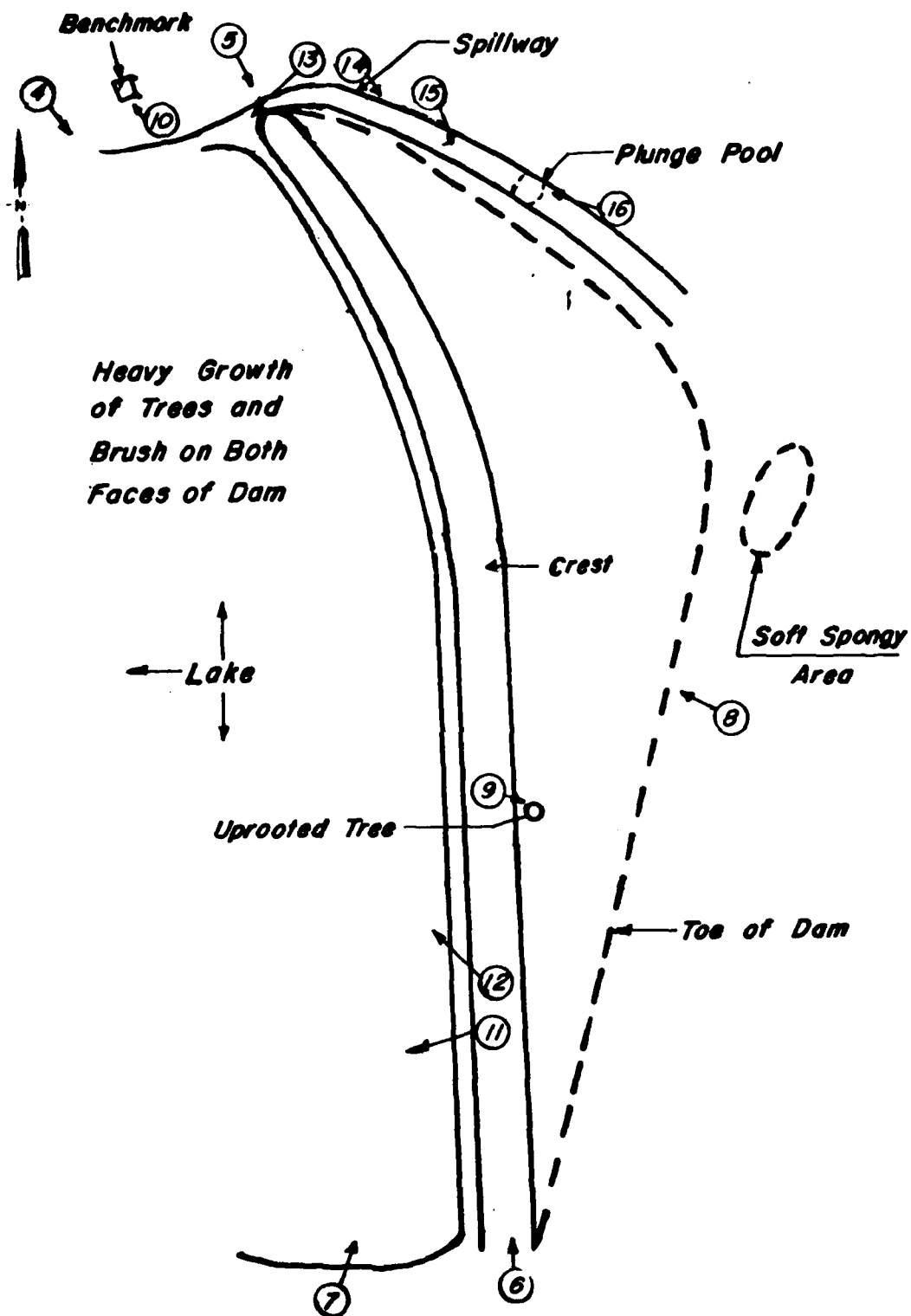
Max. Outflow = 590 c.f.s.



*APPENDIX D*

# LIST OF PHOTOGRAPHS

<u>Photo No.</u>	<u>Description</u>
1	Aerial - Lake and Watershed, Looking West
2.	Aerial - Dam and Lake, Looking West
3.	Aerial - Dam and Lake, Looking East
4.	Upstream Face - Looking SE
5.	Crest of Dam - Looking South
6.	Crest of Dam - Looking North
7.	Upstream Face - Looking NE
8.	Downstream Face of Dam
9.	Uprooted Tree on Downstream Face
10.	Benchmark, Large Rock in Foreground
11.	Lake, From Crest
12.	Lake, From Crest
13.	Spillway, Looking Upstream
14.	Spillway, Looking Downstream
15.	Spillway, Looking Downstream
16.	Plunge Pool, Looking Upstream



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 CHECKED DED  
 DATE 6-14-79  
 JOB NO. 79511

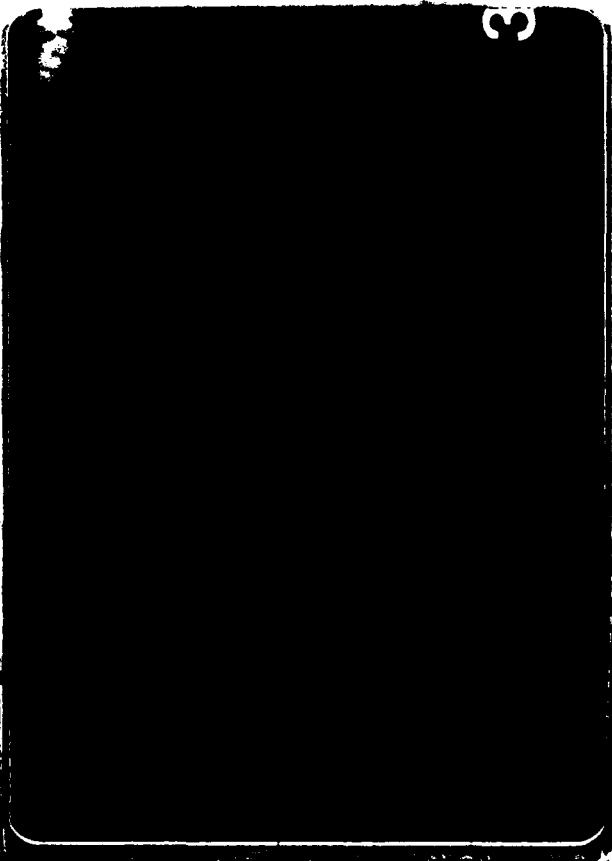
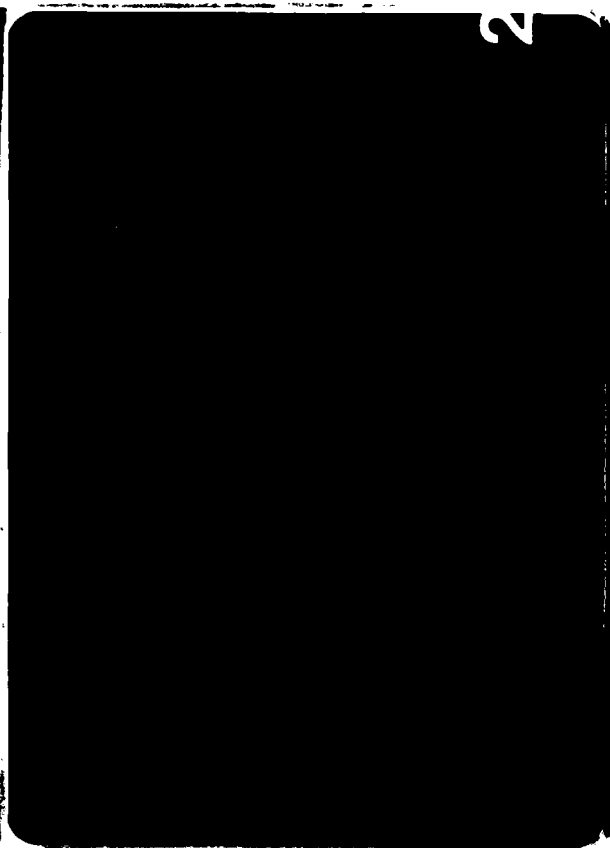


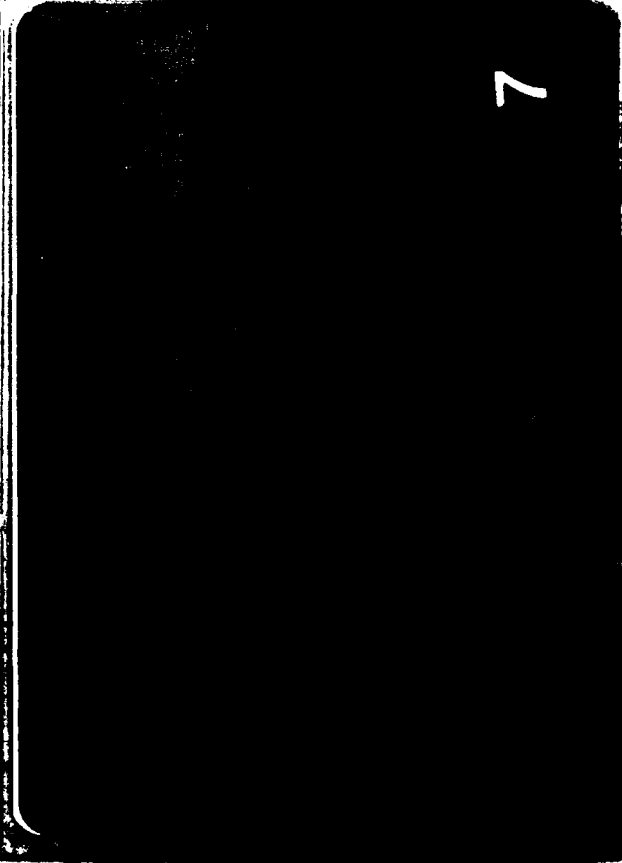
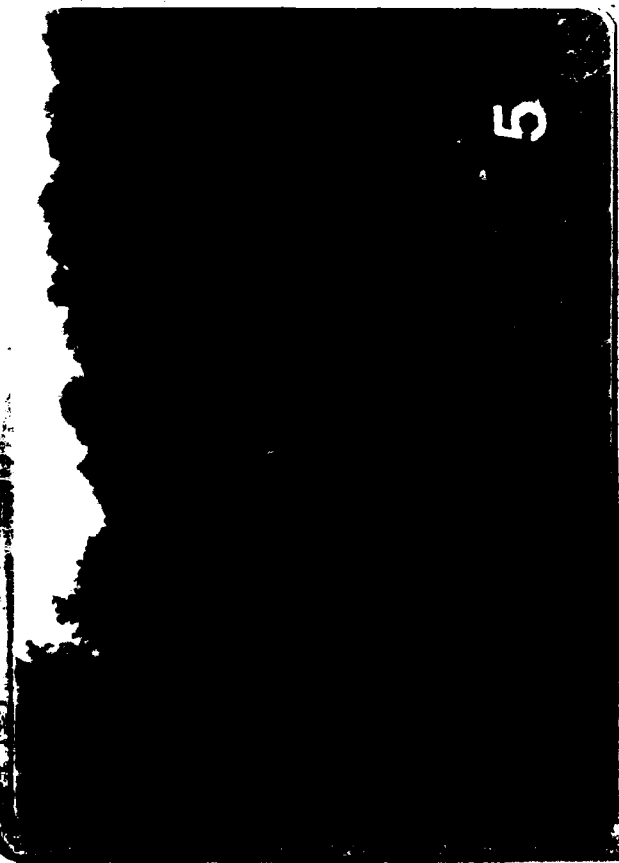
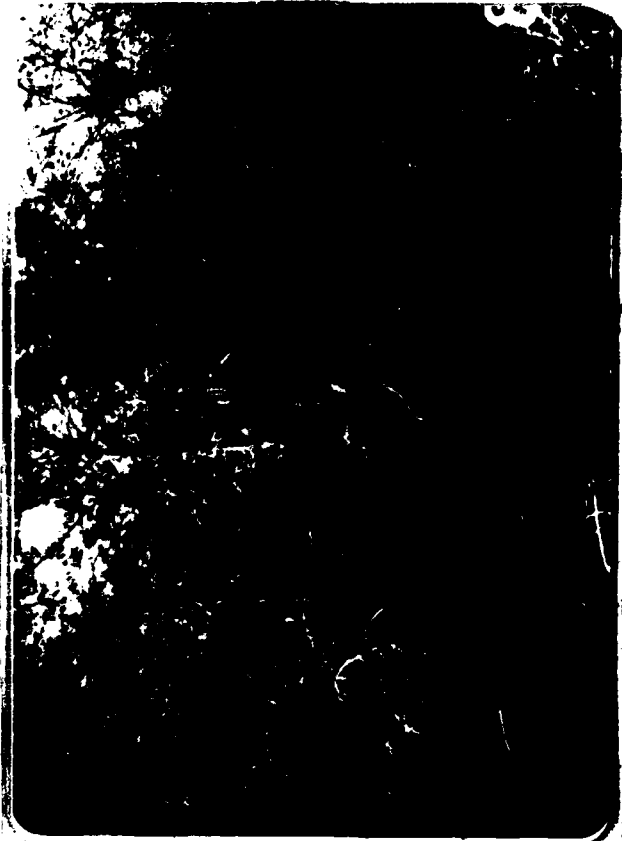
**HANSON  
ENGINEERS**

SPRINGFIELD ILL.

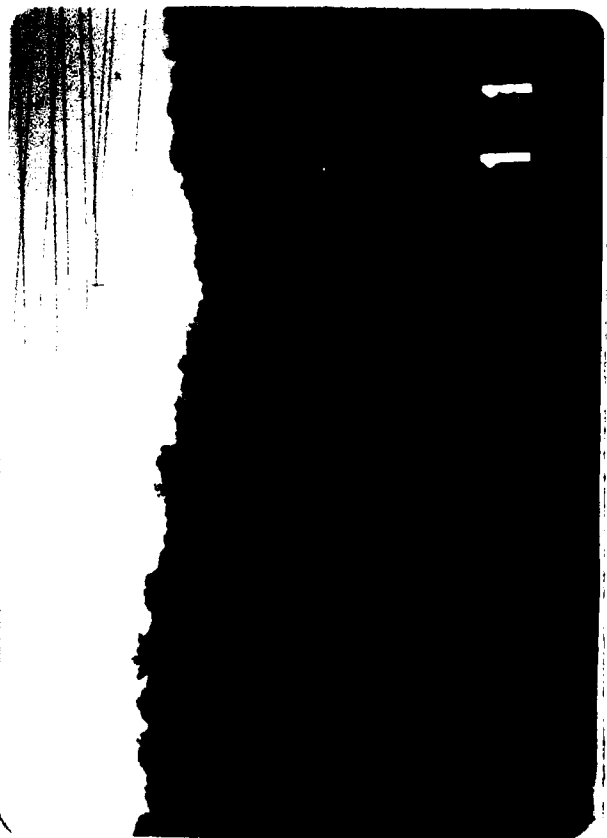
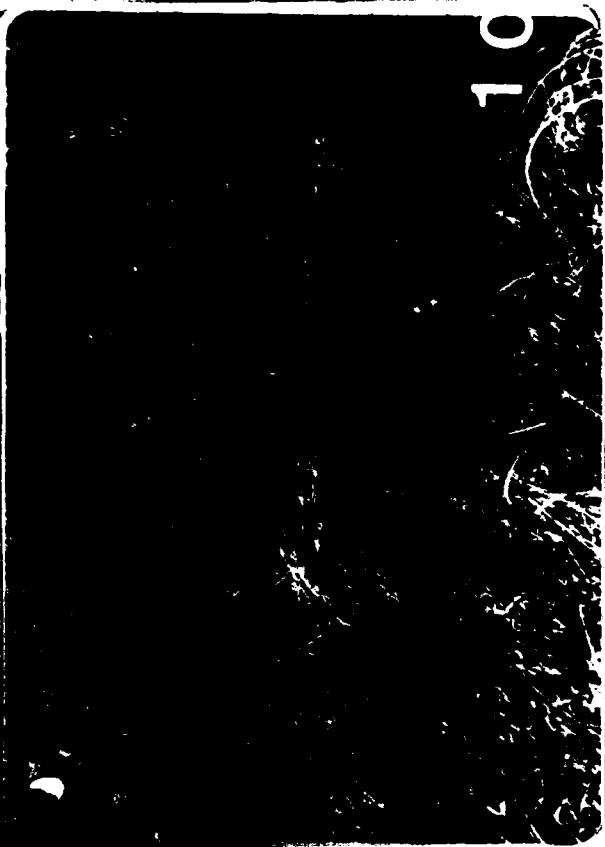
PEORIA ILL.

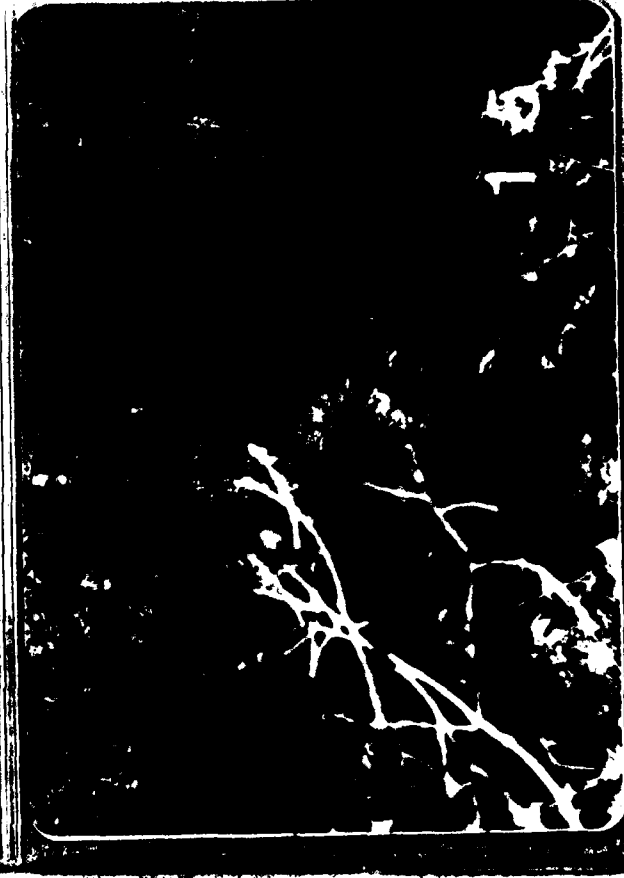
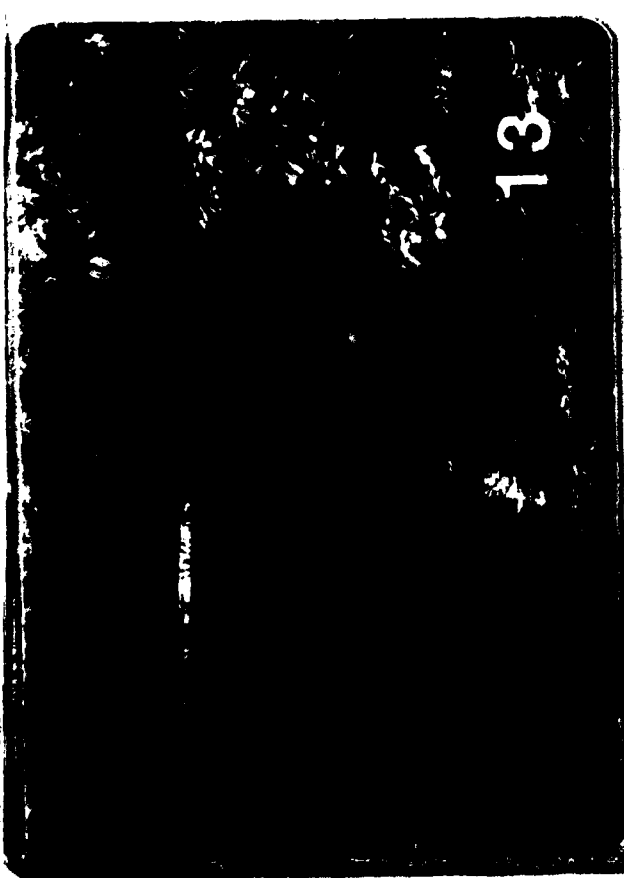
**Plan Sketch**  
**Key To Photographs**  
**Sheet 2 Appendix D**











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